PRIMITIVE COPPER WORKING: AN EXPERIMENTAL STUDY.

BY FRANK HAMILTON CUSHING.

At a meeting of the Anthropological Society of Washington, held November 15, 1892, Mr. Warren K. Moorehead read a paper on "Singular Copper Objects from Ancient Mounds in Ohio." These objects were described as discovered by himself in great numbers in the so-called Hopewell group of mounds, while conducting explorations for Professor Putnam of the Anthropological Department of the Columbian Exposition. They consisted mainly of numerous figures, large and small, made of sheet copper. Many of them showed outlines and open-work cuttings of surprising regularity, neatness of finish, and intricacy of design. The plate-like figures were of nearly uniform thickness, but the thickness of individual specimens slightly varied. Although these specimens exhibited characteristic Indian modes of artistic treatment, it was thought that a primitive people like the so-called mound-builders, being unpossessed of a knowledge of smelting or of tools of iron or steel, could not have fashioned plates of such size and uniformity as many of those from which these objects had been made, merely with implements of stone. It was also believed that such a people, even if possessed of large, thin plates of copper, could not have cut them into patterns so elaborate, the lines of which were often as curved and complicated, yet as clean as scroll or stamped work. It was therefore suggested, in the discussion which followed the presentation of Mr. Moorehead's paper, that these objects were perhaps of European manufacture or, granting the art-work on them to have been native, that the copper plates from which they had been cut must have been of foreign make, since such large thin sheets of metal could only have been wrought by means of roller mills or stamping machines of hard metal.

Having practically and thoroughly learned the art of metal-working as practiced by the Zuñi Indians, having often seen and helped them make perfectly uniform plates as well as extremely

thin sheets of copper and silver by alternate hammering and annealing, then grinding with sandstone, first one face, then the other, to form uniform leaves of the metal, I joined in this discussion, representing that, whether foreign or not, none of the forms described by Mr. Moorehead were impossible of production by a people actually limited to the resources of the stone age, as the builders of these mounds are known to have been. To this statement Professor McGee, in summing up the first part of the discussion, as presiding member, was inclined, from personal experience in metal-working, to agree; but it was objected by others that the mound people could hardly have possessed a knowledge of annealing, so essential to the process of copper-beating, etc., as described by me. Thus the question was left indeterminate.

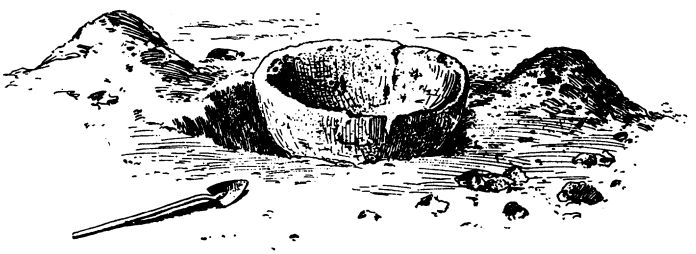

FIG. 1.—Ancient furnace exposed by excavation.

Being aware that the annealing, fusing, and soldering or brazing of soft metals was known and practiced throughout a large area of the Southwest prior to European contact, I did not question that annealing, at least, was also known to the mound-builders. Methods of prehistoric metal-working in the Southwest, with examples of which I am acquainted, may be briefly referred to in this connection. I have found evidence that ore rich in scales or seams of copper too minute to be useful in the native state, was there quarried, and first roasted in an open fire, then baked, so to say, or partially smelted in a kind of subterranean funnel-shaped oven-furnace or kiln (Fig. 1) terminating at the base in a round, nearly flat-bottomed pot or relatively small pocket (Fig. 2). Smelting in this kind of furnace or kiln was accomplished by introducing only a small quantity of the ore at a time, surrounding and covering it with fuel, firing and

replenishing the latter until fusion resulted.* On cooling, the mass of cinders, slag, etc., was raked out, and the copper or other metal culled from the pocket at the bottom of the kiln, where it occurred in buttons or irregular nodules. I have examined and excavated several such prehistoric oven-furnaces as above described and figured, especially near ancient copper quarries or pocket mines on the southern border of the Salado valley, Arizona. Except that they invariably possessed terminal pockets and contained an excess of slag and charred greasewood, they in nowise differed from the many true ovens found in the same region in connection with the ruined pueblo-cities of the contiguous valley-plain. In fact, it may be conceived that the crude art of smelting here referred to might easily have been discovered through the earlier practice of the Pueblo peoples of pre-

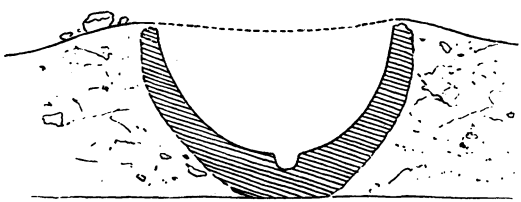

FIG. 2.—Section of ancient furnace, undisturbed.

serving food or rendering green-corn, mescal, and various roots palatable, by means of stone-baking in great underground oven-kilns. Even in the food-kilns near the ruins, used apparently only for cooking, the heat was sometimes so excessive that, combined with the natural alkaline flux of the soil in that region, it caused stones (although specially chosen for their comparative infusibility) to fuse into large slag-cemented masses.

In order to test my archeological observations and some vague

* On reading this manuscript to my learned friend, Mr. Walter William Palmer, a mining engineer of many years experience in Mexico, he informed me that the Indians of the sierras in Sonora and other parts use semi-subterranean ovens almost precisely like those discovered by me in the Salado valley, and that in smelting with these furnaces very dry twigs of greasewood only are used as fuel, the fire being closely watched and evenly replenished until fusion takes place. In this way they smelt even the sulphur ores of copper and silver with entire success. The presence of greasewood charcoal in the Arizona furnaces may therefore be taken as fair evidence that they were used, as I have suggested, for reducing ore.

Zuñi traditions regarding this method of reducing ore, I once gathered, while traveling through a portion of the Zuñi mountains, several stones showing traces of clear copper. Making a large fire in a hollow (dug there in former times by Indian turkois miners), I cast the rocks into the middle of it, gradually increasing the fire until the stones were aglow with heat, and, keeping it up for some hours, allowed it to die down. Afterward, on raking the embers and ashes away, I discovered several small buttons of copper. This almost natural kiln was far less perfect than the primitive oven-kilns above described, yet the experiment was a demonstrative success.

The primitive Pueblos worked nodules of copper thus obtained by alternate hammering and annealing. There is evidence further than this, that the more advanced of these peoples, whose southerly remains I exhaustively investigated while conducting the Hemenway explorations, were possessed of a knowledge of hardening copper with silex introduced by a combined process of manipulation and annealing; that they sometimes fused together very small buttons of copper over hollowed stones to form ingots or slugs for their larger hammered work, although they do not seem to have cast other objects; and that they understood what I may term ember-brazing, whereby separate small parts of ornaments and bells were joined together without the aid of fusible alloys or solder. Studying specimens indicating all of these processes, I began, while still in southern Arizona, and have since carried to successful completion, experiments in them all, with purely primitive appliances and resources like those common to stone-age peoples, and in the open field only. In other words, limited by stone-age conditions and surroundings, I have succeeded in hardening copper by the introduction of silex as described, in casting ingots by fusing the metal in an open fire over grooves cut in a flat, concave stone, and in joining small bits of stone-hammered copper, both by ember-brazing, as I have called it, and by rivet-hammering or a sort of metallic interlacing with filaments or rivet-like bits of metal. Once understood, all of these methods of metal-working are extremely simple so long as the operator confines himself strictly to the use of stone implements, etc., for most of these methods were discovered through such usage, and, indeed, *entire* success in them seems to be dependent thereon.

I have here parenthetically introduced the subject of Southwestern metallurgy, which I shall further treat of in a later paper, in order to call attention to facts not generally known or believed, and to evidence how far the most advanced of our aborigines north of Mexico had carried the arts of metal-working with means at their disposal as limited as were those of more northern and eastern peoples.

In the simple hammering, grinding, embossing and cutting of native or of nodular copper as suggested by the mound specimens in question, I have also made experiments, the partial history and results of which may properly be more fully recorded here as bearing upon the above-mentioned discussion relative to art remains from the mounds of the Mississippi and tributary valleys, as well as on the problem as to whether or not the contents of these mounds could have been of purely aboriginal design and of stone-age production.

In these experiments I have been guided alike by my experience in working silver according to the methods of the Zuñis, and by my practical knowledge of other arts as practiced by them and other Indians.

It is safe to assume, as a general proposition, that no new art was ever practiced by aboriginal Americans as strictly *new*. No art, I mean, in the working of new or unaccustomed material, which was wholly uninfluenced by arts and methods which, in connection with other materials more or less like the new material, had been practiced before. Thus I am led, by the experiments related below and by other considerations, to suppose that the simpler of the aboriginal arts in metal were at first influenced by more than one antecedent art, namely, not only by various methods of stone-working, but also of bark-working, skin-working, horn-working, etc. That the characteristics of the softer metals and the Indian's conceptions of, as well as his uses for them, would naturally associate them with such materials (and thus with their manipulation) need not be specifically demonstrated; yet, as illustrating this and at the same time indicating the antiquity of metal-working in the Southwest, some Zuñi names of metal may appropriately be analyzed in this connection.

He'-we is the general term for metal. It is derived from *he'-sho*, wax, pitch, or resinous gum (*he'* signifying wax-like in the sense

of being fusible), and *a'-we*, stones—"fusible-stones" or "fusible substance of stones." The Zuñi name for the copper of commerce is, however, *te'-si-li-li he'-we*, "ringing vessel metal;" their name for native (unalloyed) copper is *he'-shi-lo-a-we*, pitch, or fusible red stuff of stones. This indicates not only that copper was known to the Zuñi ancestry before its introduction by the whites (in the shape of vessels, etc., so well made as to ring), but also that it was discovered, probably as I have heretofore suggested, not in native masses but as a substance fused, at first accidentally, from stones, and was hence named practically "the gum or pitch of stones;" and it also indicates that copper was conceived of as a kind of stone or stone material, yet as partaking in color as well as consistency (modifiability) of the qualities of pitch or waxen substances, such as the fire-cement for lacquer-like work, made of pitch and the gum of the greasewood (*Larrea mexicana*) and used for coating baskets, inlaid work, etc. As the words descriptive of raw or moistened skin, horn, etc., when in the state of softness induced by heat, also refer to this wax-like quality, it will be seen that the association extended still further. This, too, is shown by another term as applied to sheet-metal, which, when very thin, is alluded to as *ke'-pis si-ne*, or "skin-thinned," precisely as a thin plate of horn or a hammered piece of parfleche or rawhide would be; and it will presently be seen that the processes of working skin to make it thin, yet stiff and flat, as well as for shaping and embossing it in this condition, were applied or might have been applied almost directly to the working of malleable and annealed or fire-softened metal in sheets.

If, then, it may be reasonably inferred that the mound-builders were possessed of a knowledge of annealing, the significance of these facts and of my experiments as in part suggested by them will be made more obvious. That the mound-builders must have been possessed of such knowledge may be inferentially assumed from the above, and is still more strongly evidenced in other ways.

1. In the working of shield-hide, parfleche, and horn, as well as in the straightening of arrow-shafts or the bending of saplings, not only was heating (practically suggestive of annealing) constantly resorted to by almost all Indian tribes, but also by the use of perforated horn or bone plates and burnishers of horn or bone (themselves worked by fire-softening) in these simple arts, the

essential properties of the draw-plate and burnisher for metal were discovered long before metal itself was.*

2. In the seventeenth century tribes on the Ohio were found still using small rude rods of copper for piercing pearls, horny substances, wood, etc., by heating them to redness and thrusting them through the objects to be perforated.

3. Numerous mortuary altars have been found in the older mounds covered with articles of copper which, having been sacrificed in fire, were fused together in many instances, and in some cases were so thoroughly melted as to form almost homogeneous masses.

4. It is not a little surprising that those who have supposed these ancient copper-workers of the north were confined to cold hammering, have not reflected that fire was used in nearly all the Lake Superior mines or quarries, whence the copper was chiefly derived, in the same manner as at Flint ridge and in western New York in the quarrying of flint from limestone, for the removal of copper from its rocky matrix. Fire also was occasionally employed to burn away or disintegrate small portions of rock when found adhering to bowlder or drift copper, as shown by a specimen I have seen from Wisconsin.

It seems to me improbable, indeed inconceivable, that a people using fire in connection with copper and the working of similar materials in so many ways as these, should not have become acquainted almost at the outset with its value for softening (as well as in at least partially reducing) metal, even had not the

* Draw-plates made from the scapulæ of deer were formerly used by Zuñi and other Indian metal-workers of the Southwest in forming silver and copper wire from slender hammered rods of those metals. The holes in these draw-plates were very numerous and nicely graded from coarse to fine, and wax mixed with tallow was freely used to facilitate the passage of the rods through them. The rods were not, however, unless very slender, drawn through merely, as in our corresponding operation with the steel draw-plate, but were passed through by a combination of pushing and pulling, accompanied by a twisting motion, just as arrow-shafts are rounded and straightened in a perforated horn plate. That these bone draw-plates were the direct descendants of the perforated horn arrow-straightener cannot be doubted. I am told that the Sierra Indian filagree-workers of northern Mexico also use such plates, made from the scapulæ of sheep, and with a like bone implement I have myself succeeded in making copper wire as fine as coarse linen thread.

liable accidents of daily life in the use at first of cold-fashioned articles of the latter material made them acquainted with these properties.

In copper-working, then, to reproduce with stone-age appliances the objects under discussion, and thus to ascertain whether they were prehistoric, and, if so, to relearn the actual methods by which they were made, I have not hesitated to freely use fire for softening my slugs and plates of metal; and in drawing out sheets by hammering with stone bowlders or mauls I have, for like reasons, simply employed the methods used by the Zuñi and other Indians in hard-dressing skin, horn, and like modifiable materials.

When these peoples thus dress a piece of rawhide they lay it upon a very smooth, flat, but rounded bowlder (of diorite usually) and "rub-hammer" or hammer it slantingly ("coaxingly," the Zuñis would say) from the center outward, thence from the peripheries inward but always by oblique strokes tending outward. Now I find that a piece of copper or other soft metal thus treated, rapidly spreads, behaving somewhat as the rawhide does. When a maul with a slight, but very firm grain is used (a maul of compact granite or quartzite, for instance), the rough face aids the thinning and spreading of the metal (until very thin) by displacing the surface molecules at a multitude of minute points, thus pitting the face of the metal and keeping it from becoming harder and more brittle than the mass or medial portion; thereby also the metal is toughened (since the blows fall always in different places), is not so rapidly hardened throughout, and is actually not so liable to scale or crack as when treated with a smooth-faced hammer of iron or steel. As soon as, in my experiments, I have in this manner reduced a plate almost to the desired thinness, I have with a smoother stone (like the back or butt of a worn-out, well-polished diorite celt) supplied with a flexible handle, gone over both sides of it to reduce all the larger irregularities and to partially smooth the surface where pitted by the coarser maul. This may be done partly by hammering, partly by combined rubbing, pressure and rolling with a smooth, unmounted bowlder. I have then proceeded precisely as an Indian would in dressing down the flesh side of his hammered sheet of parfleche. I have taken flat-faced pieces of fine sandstone and, laying the sheet of metal on a firm, level

spot, with a buckskin underneath to act as a buffer and also to help hold the plate in place, have ground, then scoured, first one face, then the other, until uniformity of surface and of thickness have been secured.

It happened that in some of these experiments places which had been accidentally grooved or indented in the sheet by the corner of my rubbing stone, or otherwise, when it was turned over and carelessly ground on the other side, were worn or cut through. This taught me what I had before suspected, both from the study of skin-working and from very natural inference, that the sheet-metal, even when thicker than that of which the ancient specimens usually found in the mounds were fashioned, could be cut into any form or perforated in well-nigh limitless variety of pattern by pressure-grooving, repoussé, or line-embossing from one side or surface, and by grinding across the resultantly raised lines of the other side or opposite surface; and in this further development of the experiments I as constantly resorted to methods in vogue among Indians to-day for embossing skin, etc.

FIG. 3.—Ancient sheet-copper eagle figure from an Illinois mound.

For instance, in one of my experimental efforts to reproduce the celebrated sheet-copper figure of an eagle (Fig. 3) found many years ago by Major Powell in a mound near Peoria, Illinois, I first prepared my plate of metal as above related and softened it by heating to redness for several minutes on a brisk ember fire. When cooled I lightly traced the outline of the figure on one face of the metal plate, and placed the latter, with tracing uppermost, on a yielding mat of buckskin, folded and laid on a level, hard spot of ground. Then I took a long, pointed tool of buckhorn and, adjusting the butt of it against my chest and the point to the design, pressed downward with as much of my weight as was needful to make it sink slightly into the metal

(Fig. 4), and, continuing the pressure evenly,went over all of the longer lines of the tracing with it. Moderately deep and remarkably sharp smooth grooves were thus plowed or impressed in the ductile metal wherever the horn point had traversed it, except along upward curves and around sharp turns or where hard places happened to occur in the plate. In order to deepen the grooving at such points as these, I found that it was only necessary to use a rounded chisel made from the humerus of a

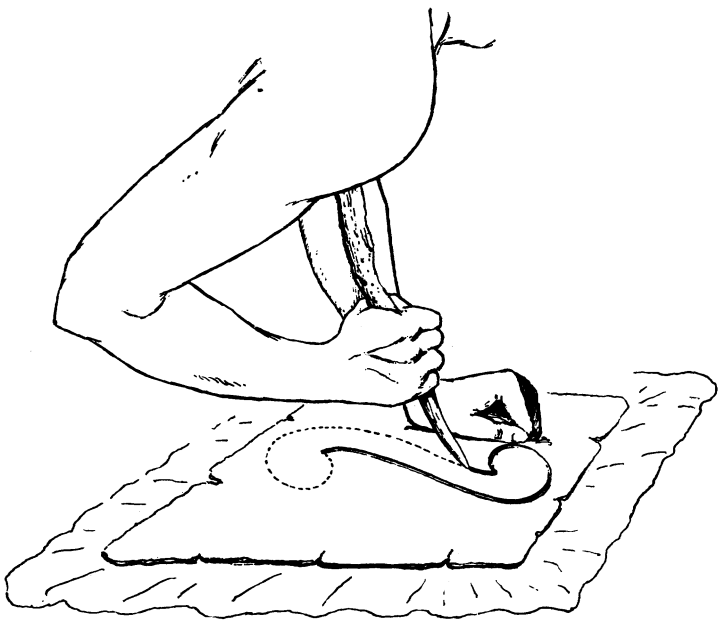

FIG. 4.—Method of grooving copper plate with horn embossing tool preparatory to severing.

deer, like an Indian skin-flesher of bone. This, firmly grasped and pressed by the hand alone, then rolled or rocked to and fro, served admirably to deepen straight grooves to any extent desirable, or, if twirled while it was being pressed down and rocked, to impress or deepen curved lines (Fig. 5).

When all the lines of the design had been completed by these combined processes of pressure-drawing with the horn tool and pressure-rocking with the bone tool, the plate, on being turned

over, exhibited in clearly raised outline the reverse of the pattern I had traced and thus embossed. On grinding these sharp ridges crosswise with a flat piece of sandstone (Fig. 7, A) their apices were speedily (within seventeen minutes) cut through, and the eagle form as outlined by the embossing (Fig. 8) was thus completely severed from the plate, leaving the portion from which it had been removed like the open space of a stencil.

In subsequent experiments I discovered many additional processes, and developed improvements on the earlier ways of working. Perhaps the most significant of these latter was the employment of part-patterns (cut out of firm, yet slightly flexible rawhide by identical methods) as guides for figures of bisymmetrical outline, such as are so often found in the mounds. By firmly holding one of these half-patterns flat against the plate to be embossed for cutting out, then running the horn point around it to strike-in one side of the design, reversing the pattern and continuing the embossing operation for the other side, an outline at once intricate, and of course bilaterally symmetrical, could be almost as rapidly struck-in as could be the simplest device. Such outline could also be repeated any desired number of times.

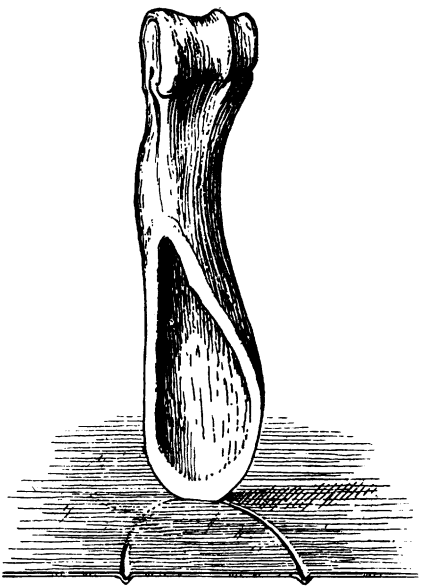

FIG. 5.—Method of grooving copper plate by pressure and rocking motion with bone chisel.

Singularly enough, the edges of patterns cut out by embossing from one side and grinding off on the other require but little finishing. The marginal lines are very clean and not much thinned. This may be explained by the accompanying sections of an embossed plate.

The groove being made sufficiently deep (Fig. 6, A), the upper surface of the metal is depressed to or beyond the opposite surface (Fig. 6, B, *a a*), so that the groove itself is bounded by walls, the axes of which are at an obtuse angle to the plane of the plate. Thus, when the plate is reversed and the apex of the groove is ground off (Fig. 7, C), these walls are in turn cut off nearly at right angles to their vertical plane, and are therefore blunt and slightly beveled, not thinned to a knife-edge, as might be expected. On being hammered down (Fig. 7, D, *a a*) these edges appear as they would if cut almost vertically by a powerful graver or shear.

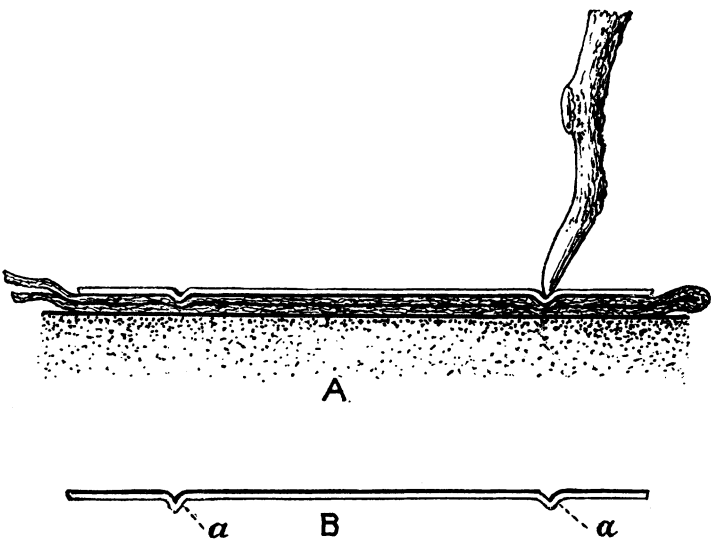

FIG. 6.—Sections showing method of line embossing (A), and depth of groove necessary for severing by grinding (B).

Before my visit to the Columbian Exposition it had been impossible for me to examine originals for traces of processes kindred to those I had employed. An inspection of Mr. Moorehead's specimens exhibited there, and, subsequently, of those comprising the collection now in the Bureau of American Ethnology, convinced me that they had been worked by methods probably similar to, if not identical with, mine. First, the plates of which these figures were made had been smoothed by scouring; second, the cut edges of figures or open-work patterns were slightly

beveled, except at points where they had been more or less dressed down by crosswise grinding with gritty stone; third, the edges of small open spaces, such as holes (other than drilled ones) less than an eighth of an inch in diameter (too small for the introduction of pointed grinding stones), had not been dressed from the inside, as they might have been had the artificers of the specimens possessed slender files, but had been left sharp and raised, and showed distinct trace of the horizontal grinding by which, after they had been partially punched or raised, they had been cut through; fourth, after the outlines and open spaces had been cut in the more elaborate of these speci-

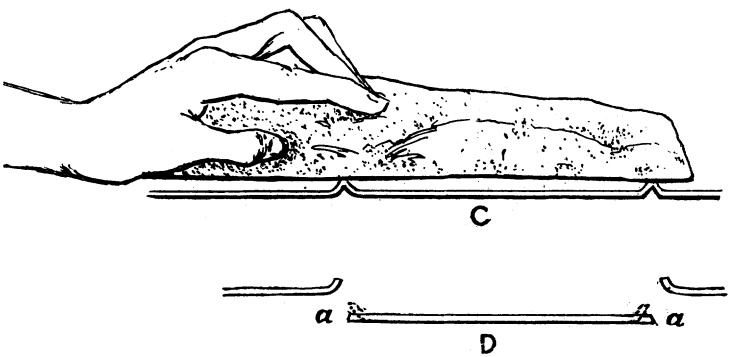

FIG. 7.—Sections showing method of severing figures from copper plates by grinding (C), and of flattening edges of figures after severing (D).

mens, the latter had been again turned over and embossed, mainly by pressure, from the side opposite the one from which they had been impressed for the cutting.

Additional points of technologic significance and interest, developed by my experiments and by comparison of their results with features of workmanship on the ancient specimens under discussion, might be presented. Reserving these, however, for a future paper on primitive metallurgic art in America, I do not hesitate to say, in summing up this portion of the present study: first, that I have neither seen nor heard of a single object of copper from the mounds which I cannot reproduce from native or nodular copper with only primitive appliances of the kinds described, by successive processes of stone-hammering, beating and rolling, scouring, embossing and grinding—such processes as, in more or less modified ways, are actually employed to-day

by comparatively rude Indians in the fashioning and embossing of parfleche, horn, and other like substances; second, that sufficient results of these experimental studies have been above brought forward, I trust, to establish as an easy possibility, if not probability, the aboriginal and prehistoric character of the workmanship on the sheet-copper articles from the Ohio and more southern mounds.

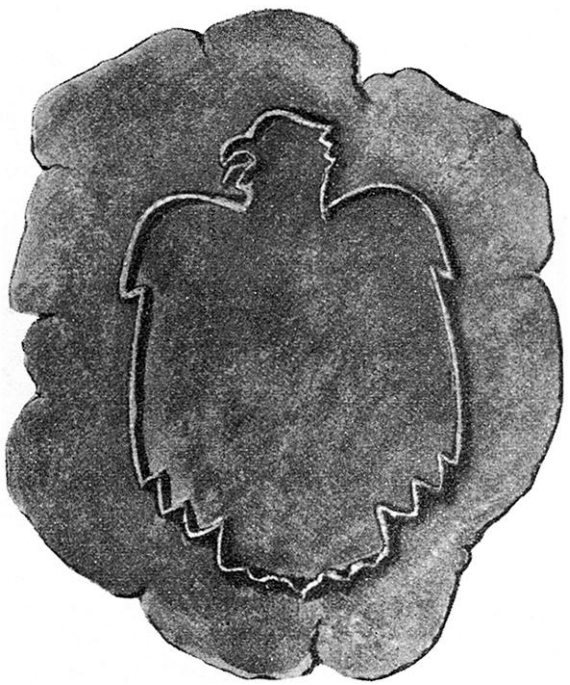

FIG. 8.—Hammered plate of copper showing line-embossed figure of eagle prepared for cutting out by grinding.

This evidence may be reënforced, I think, by a few additional brief considerations relative to especially the symbolic art displayed in these specimens, and to its relation to mound art as shown in other materials.

Professor Holmes, than whom no higher authority could be quoted on this subject, has stated that "if in the end it should turn out that these remarkable [copper] objects are the unaided

work of the mound-builders, we shall be compelled to recognize their standing in the manipulation of metal, and in the art of design generally, as unsurpassed by any other native American people."

Probably no one influence so greatly affected this high development of the mound-builders in copper-working as the occurrence in the Lake Superior region of almost limitless, easily accessible supplies of the pure mass metal. There is abundant historic evidence and there is still stronger archeologic evidence of the wide distribution of this copper among native tribes at the time of the discovery, and throughout the entire mound region, at least, in prior times. The only known deposits of native copper other than those of Lake Superior that contain occasional masses of free malleable silver are, I am told, those of the Ural mountains, in Asiatic Russia, and these were discovered and worked only in comparatively recent times. If this be true, articles of beaten copper containing patches of this pure silver, like those found by a friend of mine a few years since in Florida, afford indisputable evidence of the distance to which copper from the Lake Superior quarry mines was transported; and as in nearly all other sections of the mound area these bits of native silver have been found thus mingled with or purposely separated from copper fragments and objects, the conclusion is equally warranted as to the same source of derivation. But most significant in this connection is the fact that, previously to the present century, only one effort was ever made, so far as is known, by other than Indian stone-age peoples, to quarry or mine the Lake Superior copper. This was undertaken by the Jesuit fathers, who so signally failed that they abandoned the attempt almost immediately.

From this and from the fact that traces of vast quarrying operations on the shores of Lake Superior attest to the activity there of aboriginal miners for a very long period, we may venture to assume that this Lake Superior copper was known to the mound-builders for such length of time, and was procurable to such extent that, being workable in the natural or raw state, it inhibited their discovery of the value of smelting and casting, and correspondingly stimulated their knowledge of and proficiency in its treatment by hammering, pressure, etc.

Another influence, scarcely less potent, must have helped to develop their skill. Among all tribes of America who, when

first known or subsequently, possessed a practical knowledge of metal-working, the beginning of true artisanship was developed; that is, a distinct class of special workers existed or speedily came into existence, as among the Northwest Coast tribes, the Zuñis and the Navajos—a more distinct class than the especially skilled arrow-makers and shell-workers of more primitive conditions. This, we may believe, was the case with the mound-builders, and that the result of it was, as with the modern tribes mentioned, the development of the highest possible deftness in the use of means and materials available.

Among the mound-builders this art in metal must have been influenced primarily, both technically and otherwise, by their earlier arts in stone, bone, horn, and shell, and must have reacted later on these arts; hence remains of their finer products in all of these diverse materials exhibit striking unity of design and similarity of conventional treatment. This is especially true of their larger ornaments and amulets in shell as compared with their badges and decorations in sheet-copper, for both materials were precious and probably sacred, and both, if I may judge by further experiments, were to some extent manipulated in similar ways. Horn or wooden tools, like those employed in embossing copper, had but to be tipped with gravers of flint or other hard substances, or used in connection with sand or other grinding materials, to serve for engraving shells or cutting out sheets of mica, etc., quite as well as for working copper without these accessories.

FIG. 9.—Shell gorget, engraved with representation of contending Man-Eagles.

It is not surprising, then, that in copper, shell, and, to a less extent, in mica, the same figures are often found represented in almost identical lines and outlines, as illustrated by Figs. 3, 9,

10, and 11, reproduced by kind permission from the earlier reports of the Bureau of Ethnology.

One of the most striking features in designs of like character common to both shell gorgets and copper decorations, is their frequent bilateral symmetry, as may be seen by comparing out-

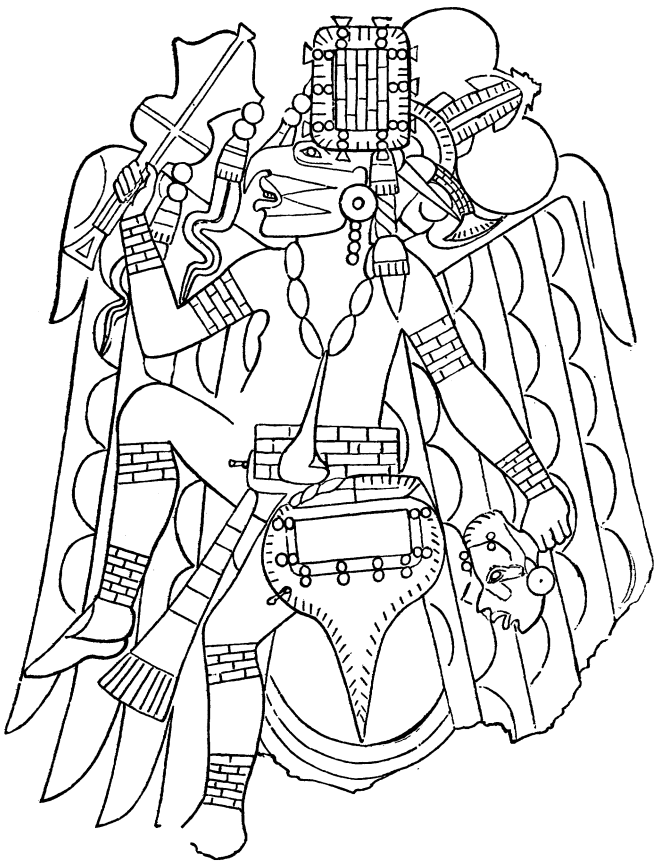

FIG. 10.—Embossed copper plate representing Man-Eagle of War.

lines of wings, etc., in Figs. 3, 9, and 10. I have explained this in the case of the copper objects as probably resulting from the employment of thin half-patterns as guides for the points of tools used in embossing (see page 103); and it seems not impossible

that part patterns of a similar nature may have been used, first on one side, then on the other, as guides for the graving and grinding tools used in carving such shell figures as the one from Tennessee shown in Fig. 9.

Another feature common to all winged figures, whether represented in copper or on shell, is the peculiar decoration of the feathers with series of semicircular indentations or cuttings along their inner edges, as shown in Figs. 9 and 11 (shell), 3 and 10 (copper).

It may be seen that some of these semilunar feather markings in the design of one of the shell specimens from Georgia (Fig. 11) are cut entirely through. This kind of open-work in engraved and carved shells is common, such semilunar incisions or perforations being particularly frequent, perhaps because of the facility with which they could be incised by working a graver back and forth inside of or around a semicircular guide, or could be perforated by drilling one large and two smaller holes close together.

There can be little doubt that the mound-builders thoroughly understood this art of engraving shell long before they had acquired a practical knowledge of copper. There can be as little doubt that when they first began to work in copper the supply of this metal was very limited. Thus their ingenuity was taxed and their abilities quickened to make as much as possible of the little copper they had, by beating and otherwise drawing it out into very thin sheets or leaves. In doing this they could not have failed to observe that as soon as thinned, the copper took the impression of anything it was being worked over, precisely as would moistened hide or softened and flattened horn. This, then, I imagine to have been their beginning in the repoussé treatment of copper. At first, we may suppose they rolled sheets of the metal around their long bone and shell beads, which in time led to the making of the long cylindrical copper beads so common in the mounds. With such sheets they also covered their double ear-beads of shell, then spool-shaped ear-buttons of horn, until finally they also made the copper ear-buttons, likewise so common in the mounds, of the metal alone. Thus, too, they coated their shell gorgets or the figure-designs on them, pressing the thin metal into the lines and spaces of these designs with tools of horn and bone. If one

of these shell figures, in which the semilunar marks on the wing feathers had been simply incised, were thus coated with thin, soft copper, it will be seen that these marks would show in the metal as semilunar grooves. If a shell figure in which the feather marks had been represented by perforations were thus coated, then the sheet-metal would sink abruptly a short way into these open spaces and show as clear-cut half-round indentations, as though punched in with a flat-faced die.

It is a fact that on all winged figures in sheet-copper thus far found, the semilunar wing-marks invariably present one or the other of these forms of indentation, either grooved outlines corresponding, as it were, to incisions on shells, or else flat depressions representing, so to say, perforations in shells.

FIG. 11.—Shell gorget engraved and carved to represent Man-Eagle of War.

It is probable, then, that this inappropriate, though characteristic and conventional way of representing feather flutings in the wings of copper figures, so natural when worked in shell, originated in the copying of such copper sheathings when severed from shells having similarly shaped incisions or perforations. The origin of yet other characteristics of the copper figures not easily accounted for otherwise may thus be readily enough explained.

The inference is that, as to design, the copper art of the mound-builders was to a great extent derived directly from their shell

art, and therefore that it was as probably indigenous. This inference is strengthened by an analysis of certain symbolic tokens, or signs of special mythic concepts, to be seen in the figures as portrayed on both copper and shell.

By examining Figs. 3, 9, 10, and 11, it may be seen that they all represent *one thing*, the Eagle God, either in his simple or animal form, but with the mark of "doom" or "war" on his face (Fig. 3), or else as the Giant "Man-Eagle of War" (Figs. 9, 10, and 11). In all of these figures of the Eagle War God, whether as Eagle Man (Fig. 3, Illinois) or as Man-Eagle (Fig. 10, Georgia), the "strong feather," or "thumbnail plume"—which "cuts the breaths" of the fiercest demons or "cleaves the strongest storm-wind"—this plume is as prominently represented at the shoulders or outer bends of the wings as it is over the wings of the comparatively modern shield-painting of the Zuñi sky god *A'-tchi-a-la'-to-pa* or the "flint-winged" Man-Eagle of War and the Thunderbolt. (Fig. 13) This, then, is a distinctive Indian characteristic, since it may be observed in the paintings or other delineations of eagles (but not of other birds), made also by members of several other Indian tribes; hence it serves to identify the composite human-eagle figures in the mound-builder specimens with the simpler eagle figure of the same series. In the latter also (Fig. 3) is an equally characteristic representation, that of the "umbilical" or "anal mark" (or sign of the "power of the bowels," as it would be called by the Zuñis). By this the figure was made not merely an effigy of the eagle, but also an amulet or fetich of him as being a god, for it was supposed (for obvious reasons) that his figure was thereby endowed with the power of

FIG. 12.—Shell engraving probably representing God of the Two Winds.

continuing the life it gained from the food of sacrifice and slain enemies.*

In the semi-anthropomorphic man-eagle figures, however, this mark is invariably replaced by the loin-cloth, the equivalent human symbol of virility or manhood, as in Figs. 9, 10, 11, and 12. This also accords with the ideas and usage of the present Zuñi and other Indian tribes.

But perhaps the most pronounced, certainly the most conclusive evidence of the mythic and sacred character of these man-eagle figures is found in the fact that each is represented with a mask, the symbol of "transformation," held in the hand (Figs. 10 and 11), to symbolize the *act of* transformation from eagle form into human form or *vice versa*, the mystic power of which these gods were regarded as possessing.

In further proof that this was the meaning intended by the portrayal of these masks in the figures, reference may be made to the simpler eagle form (Fig. 3). Although his cheek is painted with the zigzag "swift line of tears," denoting the sudden doom he as a god of war is able to cause, and although the line of "detachment" crosses his neck to signify his power to change, yet he bears no mask, being as yet *untransformed*; nor are the contending man-eagles (Fig. 9) shown as carrying masks in their hands, but would be found represented as wearing them were we able to see their faces (unfortunately destroyed), since they were depicted *as already transformed* for mortal conflict.†

*Thus Zuñi effigies of the animal gods—the fetiches of war and the chase—are supplied with this mark or with the symbol of the heart, or with both, to make them potent or open for them their "passage-way of life." The ornamental bands encircling the tops and bases of their food and water vessels are also left slightly open or spaced, on account of a similar animistic conception of them.

† I would call attention to the fact that these interpretations, while due to the exercise of "imagination," are not fanciful. They represent real Indian concepts, well known to me through having myself been required to perform, according to elaborate ritual and formulæ, the ceremonial of transformation (or exchange of my spirit person) and other like symbolic acts founded upon identical concepts; for it is held by these and other advanced Indians that the dancer in the sacred dramas, after having his face properly painted (see Figs. 10, 11, 12, and 13), can change or transform his personality by simply putting on or taking off his mask, usually with the left or non-combative hand, as in these.

The bearing of these observations on the question as to whether or not the copper and shell arts of the mound-builders, both in design and workmanship, were indigenous, is important. They show conclusively, I think, that both arts were Indian, and that both were North American Indian.

Thus, some of the copper works may be as ancient as the fondest romanticist could wish, or on the contrary (and some of them probably are), as modern as the days of De Soto; but, whether ancient or recent, they are of Indian origin and neither Oriental, as some have claimed, nor European, as others have naturally been led to infer by the very high degree of workmanship they exhibit and by certain supposedly analogous art traits. I think it has been shown by the foregoing "experimental study" that the beauty and finish of the finest of these specimens might readily have been produced by the mound-builders. I also believe that the designs themselves have been accounted for as pertaining equally to a native, very old, as well as to a more recent indigenous technical art, and as being specifically Indian in respect to both mythic motive and the conventional or artistic expression thereof.

The only figure in the series which seemingly exhibits marked European traits is that of the eagle; but this also exhibits, as I have shown, very significant characteristics of North American Indian art, and, as indicated by the scallops of the wing feathers, belongs to the very old native family of Man-Eagles. The bilateral symmetry of this specimen, so suggestive of the heraldic "eagle displayed" (*l'aigle éployé*), is explained as a technologic feature, the result of pattern tracing; while the "regard" of the bird, the turn of his beak *toward the left*, is decidedly unheraldic; for all charges, on or off of European armorial shields, must "regard the dexter side." Finally, the treatment of the legs and claws of this and other copper eagles also appears heraldic; but while unusual as an Indian mode of treatment in *painted* figures, it is nevertheless Indian; for example, the Zuñis, the ancient Saladeños and the modern Haidas, managed the legs and claws of eagle and composite eagle figures made "in the flat" (or cut out of hide, thin wood or slate) in almost precisely the same manner.*

*Several questions arise in this connection, among them being: 1. If the hammered or sheet copper articles found almost universally in

There is one characteristic of the composite human-eagle figures which raises the latter, artistically, but not conceptionally, above anything else of the kind in native American art. The Man-eagles are provided with arms as well as wings, as were those of Assyria, Egypt, and Europe; but this does not prove the designs of them to have been either Oriental or European in origin. It simply demonstrates the artistic capacity of those who fashioned them. The conception was a well-established Indian idea.*

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the mounds were of European origin, why is it that *cast*-copper objects, being cheaper, more readily made and duplicated by European artisans, and more suitable for certain purposes than if made in the flimsy sheet-copper form, are never, so far as I know, found in the mounds—even heavier work, celts, etc., being hammered, not cast? 2. Was there an artisan of the sixteenth or seventeenth century who could or would have grasped so thoroughly the special Indian spirit of art as displayed in these composite specimens? I find that I cannot reproduce them faithfully unless I recognize just what they expressed, and at least *finish* them with primitive tools. I can copy them otherwise, but my copies are easily distinguishable by marks that only the greatest care can eliminate. 3. The mound-builders had already waned when De Soto reached the Mississippi. He and others saw descendants of them who were still building mounds, it is true, but they were comparatively few. Hence we can expect to find only in comparatively few of the typical mounds any trace of European art, whereas these shell and copper figures are found far and wide. I am here, be it understood, considering evidence as to the date and character of these works in copper and shell rather than as to the date of the decadence of the typical mound-builders, which latter event, I believe, may not necessarily have taken place very long prior to the discovery.

*For example, Zuñis have certainly not borrowed their idea of the Whirlwind God; yet they clearly conceive of him as a being who wears the face of an eagle, has the body, arms, hands, and legs of a man, the claw-feet, wings, and tail of a vulture, the feathers of which are filled with "flint sand." Yet when a native artist paints this composite monster, he gives him wings and tail, but no arms and hands (as in Fig. 13). He will tell you that the God, when flying (in which characteristic act he is always depicted), "has to use his hands and arms to help flap his wings withal;" but the plain fact of it is that the Zuñi is not so good an artist as was the mound-builder. One of their best decorators once attempted to draw for my edification an angel like the cherubim belonging to the old Franciscan church of his pueblo. He strove hard to separate the arms from the wings (as he remembered having seen them separated in the statue), but ended by depicting them *laid along the tops* of the outspread wings.

The presence of certain ornate designs in the Moorehead collection, which seem at first "too good" to be Indian, are in form neither different from nor better than excised plates of mica of undoubted antiquity from the mines of the Carolinas. The presence in the same collection of certain seemingly Oriental symbolic figures may be explained as perfectly natural indigenous growths. Such is the decorated Swastica cross, which, in cruder form among the Havasupais, Pimas, ancient Pueblos, and Mexicans, simply symbolized the four winds and directions in one as the "all-wind" sign. It was derived from the earlier symbol of the cross of the four directions, inclosed by a circle or square, which in turn symbolized the horizon, or the four horizons. When this was made open at the four corners "to let the winds in" it became the Swastica or *world*-wind symbol.

FIG. 13.—Zuñi shield painted with representation of the flint-plumed God of War and the Thunderbolt.

The art displayed in these mound-builder specimens certainly resembles that of Mexico and Central America. This resemblance is not detailed and may be adventitious,* or it may, to a slight extent, indicate

* An illustration of this may be seen in the engraving on a shell gorget from Missouri (Fig. 12), which represents, apparently, a God of the Winds—perhaps of the Two Winds, or good and evil breath—and is more or less like a Mexican figure; but this resemblance is merely superficial. As would be the case in a Zuñi representation of the Dawn-God blowing the wind of the morning dew through a flute with a flaring gourd-shell mouth, so this personage is shown as if blowing through a somewhat similar instrument. In the mouth of his mask, or "double," is seen another of these, on the tube of which is cut the zigzag line of swiftness; while in his hand he carries as a baton or perhaps a thunder-mace, what appears to be a third, with the stem marked diagonally, or twisted to represent force or violence. If this were a Mexican or Central American figure the wind

derivation from one or the other of these countries by the mound-builders themselves. There is no inherent improbability in this. Mayas and other Central American peoples were waning when Hernandez de Cordova first penetrated their territory, as the mound-builders were waning when De Soto crossed the Mississippi; yet in Central America, in the sixteenth century, city-builders still lived, as descendants of the mound-building peoples were still building mounds in the time of De Soto; and these latter were noteworthy voyagers in canoes, had some silver, more pearls, and abundant copper. Being such expert navigators in canoes, the enormous size of which astonished the Spanish adventurers and was known even to the far-away Pueblos, could they not well have visited southern peoples and given to them, quite as likely as taken from them, art forms?

The art of the mound-builders is in many details quite as like that of the northwest coast as it is like that of the south. In other points the similarity is greater, that is, more general, as the clay trenchers (which are obvious survivals of wooden trenchers extremely like those of the northwest coast) and numerous incised bone tubes will bear witness. How is this to be explained? By the theory of independent development, which is probable, or by a theory of common derivation or descent—alike of some of the Mexican peoples and of some of the mound-builder peoples—which is only possible? Yet there are considerations of import in answer to this question, but they belong even less to an experimental study of primitive copper-working than does the latter or analytic half of this paper.

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would be shown by comma-, flame-, or cloud-shaped marks issuing from the mouth of the individual. Again, unlike the Mexican and Central American figures, but typical of other delineations of the mound-builders (Fig. 10), this character wears at his hip a pouch, decked with bosses and plates of copper. All of his other accouterments, too,—copper ear-buttons, the copper crest or comb over his mask, etc.,—are crude, but characteristic representations of articles found buried and similarly associated with the dead, in mounds from Ohio to the Gulf, articles as distinctive of the mound-builder Indians as the elaborate plume-dresses, obsidian-spiked war-clubs, and the throwing-sticks of Mexican figures are of the Aztecs. On the whole, this art of the mound-builders seems sufficiently self-centered to stand by itself as well as better-known arts of other ethnic areas of the continent.